The rattlesnake capsules ingested by the second patient in this report were purchased in Mexicali, Mexico, just across the United States-Mexico border of California and about 100 miles south of the Eisenhower Medical Center in Riverside County. Although S arizonae was isolated from these capsules by the Food and Drug Section of the California Department of Health, different serotypes of Salmonella organisms were identified in each lot, indicating the nonuniform distribution of Salmonella serotypes in the specimens.

Salmonella infection in humans results in gastroenteritis, enteric fever, bacteremia (septicemia), or localized abscesses. Of the eight previously reported cases of this infection in patients who consumed rattlesnake capsules, seven were bacteremic and three were localized infections.[6-11] These findings stand in contrast to those of reviews of 1959,[12,13] 1967,[4] 1970,[14] 1975,[15] and 1976,[16-18] where two thirds of all A hinshawii (S arizonae) infections were localized to the gastrointestinal tract and the remaining third were equally divided between localized infection and bacteremia. The two patients in this study had bacteremia, and in one patient a localized abscess was found in the left iliac muscle. Noteworthy, all 10 patients with rattlesnake capsule-induced S arizonae infections were Mexican-American and residents of California (7), Texas (2), and Arizona (1). The two new cases reported in this communication further emphasize the presence of underlying medical disease and immunosuppression, residence adjacent to the Mexican border, and the invasive properties of S arizonae. Ampicillin, chloramphenicol, the combination of trimethoprim and sulfamethoxazole, and some β-lactamase-stable cephalosporins[19] are used to treat serious salmonella infections. The lack of response to ceftriaxone is noteworthy in one patient in this study who ultimately responded to the use of chloramphenicol. In addition, one patient was cured with aztreonam therapy, an observation made by us previously.[20]

After this manuscript was submitted, three cases of S arizonae bacteremia were recorded in patients with the acquired immunodeficiency syndrome who ingested dried rattlesnake preparations.[21-23]

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Indolent *Staphylococcus aureus* Pneumonia

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Staphylococcus aureus pneumonia is most frequently a rapidly progressive, necrotizing infection with a high mortality rate. This impression is derived in large part from early descriptions of the illness that emphasize an abrupt onset of dyspnea, pleuritic chest pain, prostration, and high fever.[1-3] A chronic, insidious clinical presentation has also been described, however, although rarely reported.[4,5] Because the course is so commonly abrupt with a rapid progression, clinicians have been reluctant to attribute indolent pneumonitis to S aureus, even with culture confirmation.

We report a case of indolent S aureus pneumonia in a patient with leukopenia and Felty's syndrome. The purpose of this report is to emphasize the subacute presentation of staphylococcal pneumonia and its unusually slow response to therapy. Impaired antibacterial defense of the patient due to Felty's syndrome-induced leukopenia or abnormal neutrophil bactericidal function[6-8] may have been instrumental in the subacute occurrence and the persistence of pneumonia during appropriate antibiotic treatment. Alternatively, avirulence of the organism may have contributed to this presentation.

Report of a Case

The patient, a 43-year-old man, had rheumatoid arthritis diagnosed at age 18. Aspirin therapy was started; intramuscular gold and penicillamine were subsequently used but discontinued two years before admission. Felty's syndrome was diagnosed at that time, and a splenectomy done

a year later without improvement of the neutropenia. Cervicofacial actinomycosis was treated with penicillin eight months before admission and completely resolved. By the time of admission, he had had sweats, right anterior pleuritic chest pain, and a minimally productive cough for 2 weeks and malaise, anorexia, and a 4.5-kg (10-lb) weight loss for a month.

He was cachectic but in no distress; his temperature was 39.4°C (103°F). Rales were present at both bases, without rubs or focal consolidative changes. The liver was 14 cm in span and mildly tender. Chronic deformities of rheumatoid arthritis were present without subcutaneous nodules. Laboratory values were remarkable for a leukocyte count of 1.8 × 10⁹ cells per liter (0.1 bands, 0.1 neutrophils, 0.6 lymphocytes, and 0.2 monocytes). The hematocrit was 0.31, and the platelet count was normal. The serum albumin level was 29 grams per liter with a total protein of 79 grams per liter. Arterial blood gas determinations with the patient breathing room air showed a pH of 7.54, Pco_2 3.9 kPa (29 mm of mercury), Po_2 7.3 kPa (55 mm of mercury) and oxygen saturation 0.92. A chest radiograph showed a right upper lobe anterior segment infiltrate and smaller infiltrates in the right lower and middle lobes (Figure 1). A sputum Gram's stain showed scant neutrophils and a few gram-positive cocci; culture grew S aureus sensitive to methicillin. Serum protein electropheresis revealed a polyclonal increase in immunoglobulin (Ig) G levels. Quantitative immunoglobulin levels showed an increase in IgA and IgG (12.6 and 23.7 grams per liter, respectively). C3 levels were decreased at 0.58 grams per liter (normal range 0.83 to 1.77).

Transbronchial biopsy was done, and the specimen showed only focal interstitial fibrosis. Ziehl-Neelsen, modified Ziehl-Neelsen, Gram's, and Gomori methenamine-silver stains were negative. Cultures from the biopsy specimen grew small numbers of S aureus with the same sensitivity pattern as in the sputum. Cultures were negative for anaerobes, mycobacteria, and fungi. An intravenous regimen of antibiotics, oxacillin sodium, and penicillin was started. Bronchoscopy and biopsy were repeated, adding no new diagnostic information, but culture of specimens again grew S aureus. Despite continuous antibiotic therapy over two weeks, daily temperatures rose to 38.9°C to 39.4°C and serial chest radiographs showed progression of the right upper lobe infiltrate (Figure 2). Leukocyte counts remained in the range of 1.0 to 2.0 × 10⁹ per liter with 0.2 to 0.5 neutrophils. Transthoracic needle aspiration from the anterior segment of the right upper lobe showed no organisms on Gram's stain or culture. Penicillin therapy was stopped and a course of rifampin added to enhance intracellular bacterial killing by the neutrophils. Because of persistent symptoms, fever, and worsening infiltrates, a thoracotomy was done and biopsies taken of the right middle and lower lobes. These specimens showed necrotizing bronchopneumonia with areas of vascular thrombosis, organizing pneumonitis, and clusters of gram-positive cocci. Interstitial fibrosis, consistent with rheumatoid lung disease, was also present.

Cephradine, 4 grams a day, was substituted for oxacillin despite good sensitivities of the staphylococcus to oxacillin in vitro, and rifampin, 600 mg per day, was continued. Over the next week his temperatures fell, accompanied by subjective and radiographic improvement. A month after admission he was discharged on a regimen of cephradine and rifampin for an additional 10 weeks. Follow-up leukocyte counts have remained at less than 2.0 × 10⁹ per liter, and films have shown slow and incomplete resolution of the right upper lobe infiltrate (Figure 3).

Methods

The killing of S aureus, a test of granulocyte phagocytic and bactericidal function, was assessed by quantitating the number of viable S aureus organisms after incubating with neutrophils.[9] To prepare the neutrophils, 3% dextran in a physiologic saline solution was added to an equal volume of heparinized blood and the mixture allowed to stand for 20 minutes. The leukocyte-rich plasma was recovered, centrifuged at 1,000 rpm for 10 minutes at 4°C, and residual red cells lysed with a hypotonic saline solution and washed. For the bactericidal assay, 2.5 × 10⁶ S aureus (ATCC 25923 or patient strain) in 0.3 ml Hanks' balanced salt solution (HBSS) containing 0.2% glucose and 0.2% bovine serum albumin, 2.5 × 10⁶ granulocytes in 0.6 ml HBSS, and 0.1 ml normal human serum as an opsonin were incubated at 37°C on a rotary mixer. At 30-minute intervals from 0 to 120 minutes, aliquots of the reaction tubes were removed, the leukocytes disrupted in water, diluted, and agar pour plates prepared. The results are plotted as the number of viable bacteria remaining at each sampling time.[9] Data are presented as the mean of two individual assay tube results for each time point, a standard way of displaying these data.[9,10] The experiments were repeated on a second day with similar results.

Results

Granulocyte bactericidal assays revealed decreased neutrophil killing of a virulent S aureus strain (laboratory stock, Figure 4-A) plotted as increased S aureus viability after incubation with patient but not control neutrophils. Bactericidal studies of granulocytes incubated with the patient's own S aureus organisms, however, show that this organism was killed equally well by his granulocytes as by control human granulocytes (Figure 4-B).

Discussion

Unusual aspects of this case include both the insidious nature of a usually fulminant illness and its slow rate of resolution, both of which are atypical features of reported S aureus pneumonia, which is characterized by a sudden onset and severe clinical course[1-3] with a 20% to 60% mortality.[3] A benign clinical course has recently been reported in
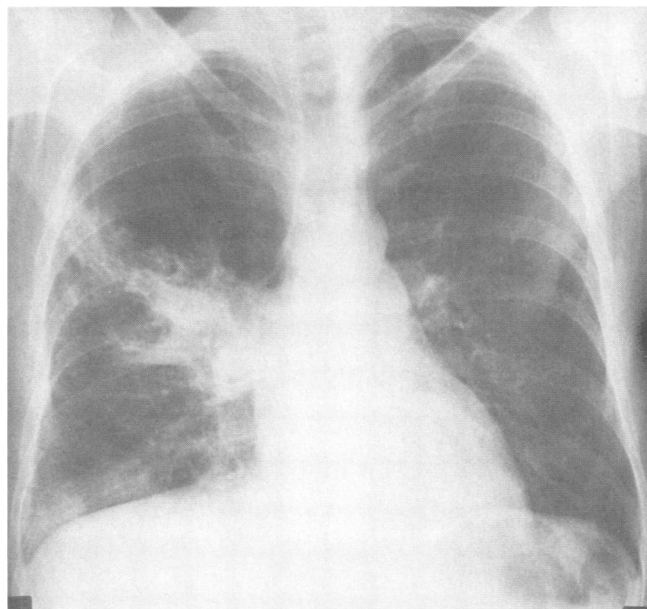

Figure 1.—A chest radiograph (posteroanterior view) taken at the time of hospital admission shows a right upper lobe infiltrate.

three adults but, in contrast to our patient, these patients had a rapid resolution of symptoms and fever after antibiotic therapy was instituted.[4,5] Patients rendered neutropenic by cancer chemotherapy may have a clinical presentation intermediate in severity. Unlike, however, the reports of *S aureus* pneumonia in neutropenic cancer patients with high (71%) mortality rates,[11] our patient had a protracted course, yet did well. Symptoms of bacterial pneumonia in these patients may be less prominent (cough and sputum production are considerably less common), but fever and infiltrates are equally common to patients with normal leukocyte counts.[12]
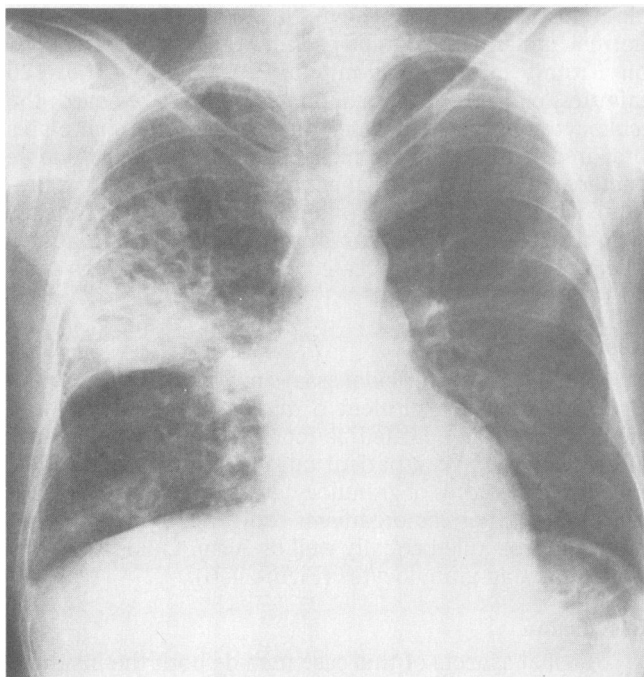

Figure 2.—A chest radiograph taken after 10 days of therapy shows progression of the infiltrate.
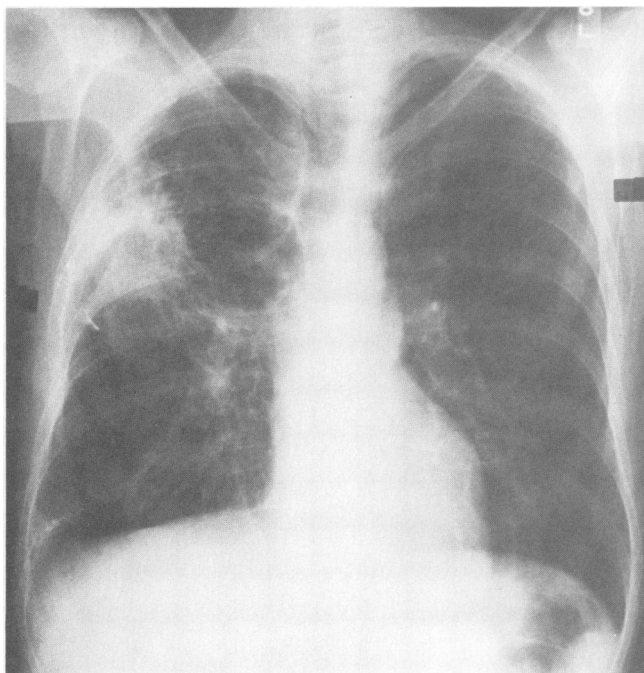
Figure 3.—A chest radiograph taken after 8 weeks of antibiotic therapy shows incomplete resolution of the infiltrate.

Our patient's low number of circulating neutrophils undoubtedly increased his risk for infection, as neutropenia has been associated with an increased risk of bacterial infection in a variety of disorders, including neutropenia after cancer chemotherapy,[13] chronic neutropenia of childhood,[14] and Felty's syndrome, the triad of leukopenia, splenomegaly, and rheumatoid arthritis.[6,15] Not only is Felty's syndrome associated with a high rate of bacterial infection, but infection remains the major cause of death for patients with severe leukopenia.[15] Altered neutrophil behavior may also increase the risk or attenuate the presentation of infection. An increased susceptibility to infection in Felty's syndrome has been attributed to abnormalities of neutrophil function that include decreased bactericidal activity,[7,16] lessened rates of chemotaxis,[16] a decreased rate and quantity of superoxide production,[8] and defects of phagocytosis.[6,7] Abnormalities of phagocytosis may be due to serum factors such as increased levels of cryoglobulins[7,10] or decreased levels of complement[6] and circulating immune complexes, both of which depress Fc receptor-mediated phagocytosis.[6,16] Our patient had severe neutropenia, low serum C3 levels, abnormal neutrophil bactericidal activity, and a long-term use of high-dose steroids, any of which may have impaired his resistance to infection. Although his neutrophils killed his staphylococcal strain in vitro, they were not equally effective in vivo, as his infection failed to clear despite appropriate antibiotic therapy. Possible reasons for this in vitro-in vivo antibactericidal discrepancy include not only the neutropenia, which was not present in vitro, and abnormalities of circulating serum factors, but also a lack of access of neutrophils to infected lung, as vascular thrombosis was noted on biopsy and neutrophils may have failed to reach all sites of bacterial accumulation. A variety of mechanisms may thus have contributed to his indolent presentation and slow response to therapy.

Differences in bacterial characteristics (virulence) may explain the range of acuity in *S aureus* pneumonia. In particular, a relative decrease in virulence may be associated with a subacute presentation. Our present knowledge of *S aureus* virulence is incomplete, but characteristics known to increase virulence include an increased thickness of the
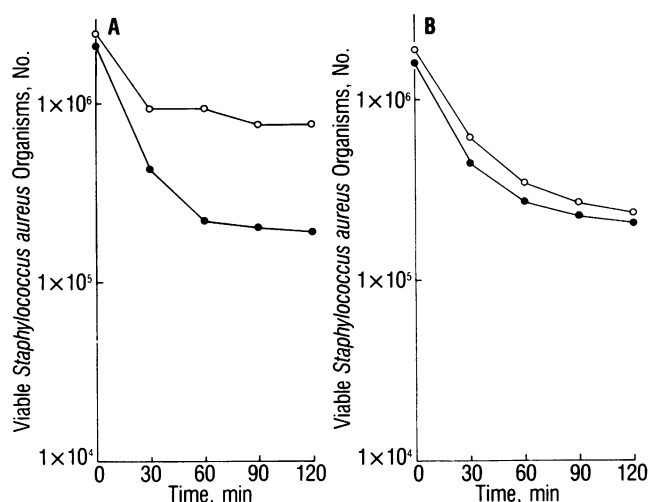
Figure 4—A, Bactericidal activity of granulocytes is assessed, plotted as the number of remaining viable bacteria after incubation with neutrophils from the patient (○) and a normal control (●). *Staphylococcus aureus* strain ATCC 25923, a virulent laboratory strain, is used in this experiment. The patient's neutrophils fail to adequately kill these *S aureus* (62.5% killing versus 90% killing by the normal neutrophils; normal range, 82% to 100%). **B,** Bactericidal activity of granulocytes from the patient (○) and a normal control (●) against the patient's *S aureus* strain is adequate: 87% and 88% killing, respectively.

slime capsule rendering the bacterium resistant to phagocytosis,[17] and the production of toxins such as α-hemolysis[18] or leukocidin,[19] which may inhibit neutrophil chemotaxis. The killing of one but not both strains of S aureus as seen on our patient's granulocyte bactericidal assay may imply differences in strain virulence, although at present we lack the diagnostic tools to explore this further.

If the development of clinical bacterial infection involves a balance between the virulence of organisms and adequacy of host defense mechanisms, a spectrum of disease penetrance should be seen. This spectrum may include the elimination of bacteria without clinical illness (avirulent organism or adequate defense mechanisms), indolent infection (avirulent organism or impaired host defense mechanisms), or fulminant infection (virulent organism or adequate defenses). We speculate that our patient had such an indolent course due to a combination of both an avirulent bacterium and abnormalities of neutrophil number and neutrophil bactericidal function.

We report the case of a patient with an indolent course of S aureus pneumonia, which has rarely been described in either immunosuppressed or normal hosts. The reasons for the indolent nature of bacterial infection are frequently unknown, but the present case with the accompanying defects of neutrophil number and bactericidal function may account for both the infection's insidious onset and delayed rate of healing. This indolent course should not dissuade physicians from the diagnosis of staphylococcal pneumonia when positive culture evidence exists.

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Ride and Tie
A Hybrid Sport With Synergistic Potential for Injury

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THE COMPETITIVE SPORT of ride and tie has become popular in the past 15 to 20 years, especially in the Rockies and in California. Races generally cover 20 to 40 miles of hilly, often rough terrain. Each team consists of two runners and a horse. During a race, one runner rides ahead on horseback for perhaps a mile, then dismounts, ties the horse to anything available, and continues the race on foot. The partner reaches the horse, unties it, rides up to the first runner, and the two then switch. This process is repeated perhaps 20 to 30 times in a race.

There are now more than 350 races, with an annual international championship. Races may contain 40 to 60 teams with varying levels of skill in both running and riding. The sport offers a multitude of opportunities for injury. The trails are often steep and washed out, a race may ascend and descend more than 2,400 m (8,000 ft) and race courses are generally far removed from hospitals. The course is often congested with both horses and runners, with the runners wearing standard road-racing attire and virtually no protective gear. Frequent mounting and dismounting stresses tack and a rider's skills. The stresses of riding competitively over difficult terrain are exacerbated by physical exhaustion from running on foot over half the distance of the race.

Methods

To better define the rate of injuries in the sport, I asked every applicant for the 1987 Park City (Utah) Ride and Tie to fill out a questionnaire detailing injuries suffered while training and while competing. An injury was defined as being severe enough to cause a loss of training time. Competitors were asked to list how many injuries they had sustained and whether the injuries had resulted from training or from competition. They were asked to describe their injuries and how they were sustained. Demographic details were also included in this survey. To follow up on these data, I interviewed by telephone the race directors of six well-recognized races, including the international championship. Details of any recalled accidents occurring over the past ten years were recorded.

Results

Only 32 of 60 competitors completed the questionnaire in full. The results are listed in Tables 1 and 2. The ages of competitors ranged from 15 to 55 with most being between 31 and 50. There were slightly more men than women. Most respondents were both experienced runners and riders. Of the 32 respondents, 26 stated that they trained at least 6 months and often 12 months per year. In training, most ran less than 64 km (40 mi) a week, and 9 of the 32 did most of the riding. This would suggest that one person, perhaps the owner of the horse, spent the most training time on horseback.